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INFLUENCE OF LIME, NITRIFICATION INHIBITORS AND SOIL INFUSION ON NITRIFICATION IN PEAT

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Abstract

Impact of lime, nitrification inhibitors (N-Serve and postassium ethylxanthate, KEtX) and soil infusion on N mineralization in an acid peat was studied. Release of NH_4-N increased significantly with pH. Accumulation of 599 to 803 mg NH_4-N/kg occurred at pH 3.4 and 6.5, respectively on day 15 and the value decreased to 205 to 381 mg/kg at 25 days and then again increased to 304 to 471 mg/kg at pH 3.4 and 6.5 with 100 mg N-Serve/kg, respectively at the end of incubation. The initial accumulation was due to mineralization of orgainc N present in the peat. The decrease in the intermediate stage might be associated with microbial immobilization.

Nitrification occurred after a long lag phase. The values of (NO_2+NO_3)-N were 0.1 to 0.6 and 11.3 to 15.1 mg/kg at 25 and 35 days of incubation, respectively. Generation of 11.4 to 15.1 and 10.7 to 14.2 mg (NO_2+NO_3)-N/kg in the presence of 100 mg/kg N-Serve and KEtX, respectively provides evidence that nitrification can proceed at pH 3.4 where an acid-adapted strain is operative.

Introduction

Nitrification has been reported to occur from very low up to pH 10, although the rate is slower at extreme values and increases as the medium approaches neutrality (Alexander, 1965). Liming acid soils generally favours the activity of nitrifying organisms (Meek and Lipman, 1922; Kaila, 1954; Weber and Gainey, 1962; Kaja, 1963). Literature suggests that a lot of work have been published on nitrification in mineral soils (Alexander, 1965; Sabey and Johnson, 1971; Pang *et al.*, 1973) and in contrast little information is

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available about nitrification in peat (Kaila, 1954; Harmsen and Van Schreven, 1955). Mandal and Parsons (1989) reported that nitrification could proceed at pH well below the normal range of strict autotrophs -- *Nitrosomonas* and *Nitrobacter* which might be mediated by either acid adapted strains of autotrophic-X or heterotrophic nitrifiers operative in acid soil. Some nitrification inhibitiors are reported to be highly selective in toxicity to the specific bacterial genus *Nitrosomonas*.

This experiment was carried out in an acid peat to evaluate the influence of lime and nitrification inhibitors on nitrification. Since the pH of the peat was very low, to be sure of nitrification inclusion of a soil infusion would be a logical approach to stimulate the process.

Materials and Methods

Incubation experiment: Samples of Red Moss peat were treated with of $Ca(OH)_2$ to change the pH to 3.4, 5.5 and 6.5 and two levels of each of N-Serve (0,10 mg N-Serve/kg) and KEtX (0,100 mg KEtX/kg) either in the absence or presence (1 ml 100/g) of soil infusion with a basal dose of nitrogen (100 mg N/kg as $(NH_4)_2SO_4$). The amount of $Ca(OH)_2$ required was calculated from pH titration curve. The treatments in all possible combinations were laid out in randomized blocks with two replications. Nitrogen and KEtX were applied as their aqueous solutions in water while N-Serve was added in solution form in acetone. Soil infusion was collected from garden soil in a ratio of 1: 5 (soil: water).

Separately 100 g air-dry (2mm) peat was weighed out into a series of clean-dry 500 ml conical flasks. The samples were brought to 50 per cent water holding capacity (WHC) and were incubated at 25C with clingfilm covering. A constant moisture content was maintained throughout the entire experimental period and aerated every day by removing the clingfilm cover for five minutes.

Samples of peat (5 g) were collected at an interval of five days over a period of 45 days after replenishing the loss of water. The sample was

extracted with 50 ml of 2M KCl solution and the filtrate was analyzed for NH_4-N and (NO_2+NO_3)-N. Sampling (5g) was also done for the determination of moisture. pH was measured after 45 days of incubation.

Analytical Technique: pH was determined from a saturation paste of peat with a combined glass/calomel electrode using a model 7020 pH meter. Organic carbon was determined by wet oxidation method (Tinsley, 1970) and that of total N by Kjeldahl digestion. CEC was measured from 1M NH_4 OAc (pH 7.0) extract (Tinsley, 1970). 2M KCl extractable NH_4-N and (NO_2+NO_3)-N were estimated colorimetrically using a Technicon Auto Analyzer by forming an emeral-green colour and reddish-purple azo dye complexs, respectively (Armstrong *et al.*, 1967). WHC was measured by following the method of Keen and Raczkowski (1921). The values for certain physical and chemical properties of the peat have been presented in Table 1.

Table 1. Physical and chemical propertise of the peat.

Peat	pH	WHC	Org. C	Total N	CEC* meq/kg	Available N (mg/kg peat)	
			Per cent		peat	NH_4-N	(NO_2+NO_3)-N
Red Moss	3.40	219	44.56	1.22	816.2	125.00	6.73

* Cation exchange capacity.

Test of nitrifiers: 20 g garden soil was incubated with and without 10 mg N/kg soil at 50 per cent WHC for seven days. Accumulation of significant amount of (NO_2+NO_3)-N (14-47 mg/kg) indicated the presence of potentially active nitrifers in the soil sample.

Results and Discussion

Effect of lime, N-Serve and KEtX, and soil infusion alone and the combinations thereof on N mineralization in peat was examined (Figs. 1&2 and Table 2).

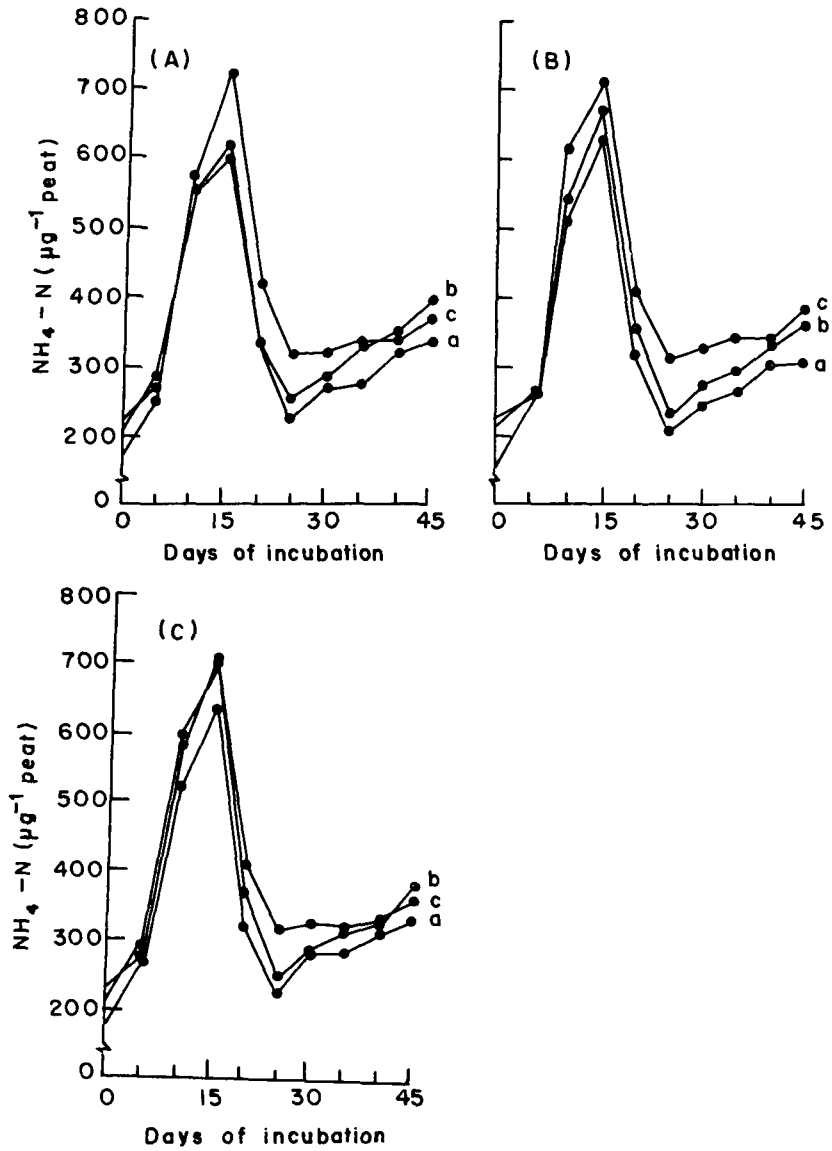

Fig. 1. Influence of pH (A), pH x N-Serve (B) and pH x KEtX (C) on recovery of NH_4-N (mg/kg dry peat) during aerobic incubation of Red Moss peat at 25C.

Legends: A = pH 3.4; B = pH 5.5; C = pH 6.5

LSD at 1% level for pH: 3.52, 3.41, 4.13, 7.22, 5.61, 2.22, 3,30, 6.52, 7.82 and 3.80 for 0, 5, 10, 15, 20, 25, 30, 35, 40 and 45 days, respectively. All other treatments are not significant.

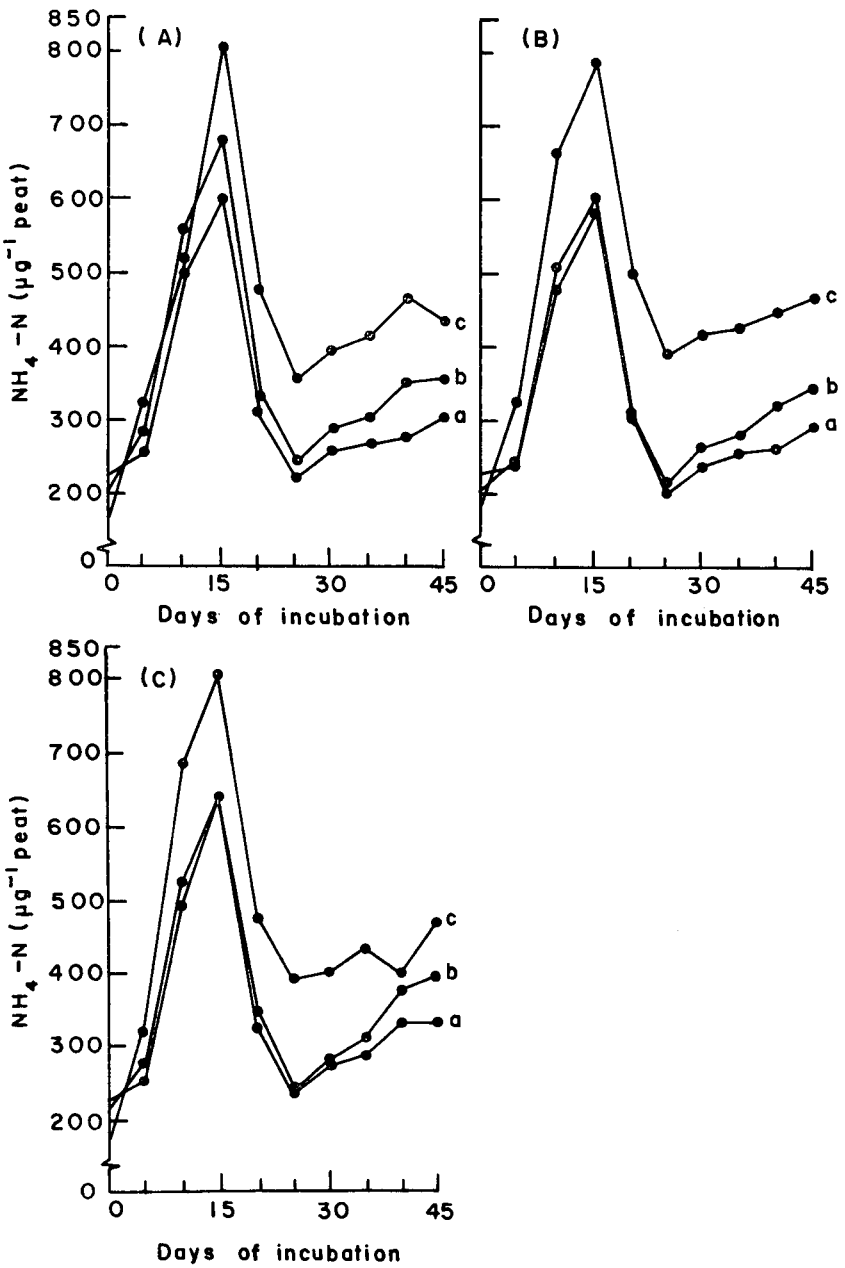

Fig. 2. Influence of pH x soil infusion (A), pH x soil infusion x N-Serve (B) and pH x soil infusion x KEtX (C) on recovery of NH_4-N (mg/kg dry peat) during aerobic incubation of Red Moss peat at 25C.

Legends and LSD same as Fig. 1.

The treatments showed significant release of NH_4-N up to 15 days of incubation (Figs.1&2). This rapid build-up of NH_4-N was due to mineralization of easily decomposeable organic N compounds present in the peat. At the peak period, the amount of NH_4-N released was 599 to 803 mg/kg in peat incubated at pH 3.4 and 6.5, respectively. Thereafter, a disappearance in NH_4-N was observed up to 25 days due to immobilization by microorganisms leaving 205 to 381 mg/kg in peat treated at pH 3.4 with 100 mg N-Serve/kg and pH 6.5 with 100 mg KEtX/kg, respectively. After 25 days, NH_4-N began to accumulate again (Figs. 1&2).

Results showed that release of NH_4-N increased significantly with pH. Addition of lime probably stimulated ammonification by reducing acidity and providing calcium. Similarly, the profound effect of lime on nitrogen mineralization was also reported by Harmsen and Van Schreven (1955) and Kaila (1954) in organic soils. However, all other treatments caused no significant effect on ammonification.

It has been noted that the peat contained high percentage of nitrogen (1.22, Table 1). However, only about 4.91 to 6.5 per cent nitrogen was mineralized at peak period i.e. at 15 days of incubation.

The recovery of NH_4-N varied between 151 and 226 mg/kg peat at zero day of incubation. Moreover, the amount recovered decreased with increasing pH (Figs. 1&2). This might be due to the fact that increase in pH caused dissociation of H^+ ion from the humic and fulvic acid fractions of the peat favouring the NH_4^+ ion to undergo complex formation which became nonexchangeable in 2M KCl extract (Carson and Dixon, 1979).

Release of (NO_2+NO_3)-N from 5 to 15 days was irregular and very low (0.1 to 0.5 mg/kg peat) and in most of the treatments the value was below detection limit (Table 2). This phenomenon might be associated with microbial immobilization. Thereafter, nitrification occurred from day 25 resulting 11.3 to 15.1 mg (NO_2+NO_3)-N/kg in peat incubated at pH 6.5 with

100 mg KEtX/kg and soil infusion and at pH 5.5 with 100 mg N-Serve/kg, respectively at day 35. Similar views were also expressed by Ishaque and Cornfield (1972) and Tan (1973). The authors observed that in highly acid soils, nitrification might occur following a lag period. Further more, too abrupt and too drastic liming may cause temporary destruction of microbial activity and mineralization of nitrogen in soil (Lipman *et al.*, 1909).

Table 2 shows that N-Serve and KEtX were not proved to be significantly effective to inhibit nitrification. High organic matter content of the peat might reduce the performances of N-Serve and KEtX by sorbing the chemicals (Bundy and Bremner, 1973; Bremner and Bundy, 1974; Briggs, 1975; Laskowski and Bidlack, 1977; Ashworth *et al.*, 1977; 1980).

Table 2. Influence of soil infusion, nitrification inhibitors and lime on the recovery of (NO_2+NO_3)-N (mg/kg dry peat) during aerobic incubation of Red Moss peat at 25C.

Days	No infusion									Plus infusion								
incubation	No inhibitor			N-Serve			KEtX			No inhibitor			N-Serve			KEtX		
	pH 3.4	5.5	6.5	3.4	5.5	6.5	3.4	5.5	6.5	3.4	5.5	6.5	3.4	5.5	6.5	3.4	5.5	6.5
20	bdl	0.1	bdl	bdl	0.3	bdl	bdl	0.4	bdl	bdl	0.4	0.4	bdl	0. 1	bdl	bdl	0.1	0.2
25	0.1	0.6	0.2	bdl	0.4	0.2	0.3	0.6	0.2	0.2	1.8	0.3	0.1	0.4	0.2	0.1	0.3	0.1
30	0.9	1.2	1.1	1.2	1.0	0.7	1.2	1.5	1.1	0.9	1.4	1.0	0.6	1.0	1.2	0.8	1.2	1.5
35	11.6	14.3	13.1	11.4	15.1	12.1	12.2	14.2	10.7	11.4	14.1	12.8	11.9	13.4	12.6	12.5	13.1	11.3
40	0.3	2.9	0.6	bdl	1.5	bdl	0.3	1.4	bdl	0.3	1.4	bdl	0.19	1.2	bdl	bdl	1.1	0.4
45	1.0	2.8	2.3	0.8	2.1	0.4	bdl	2.8	0.7	0.3	3.2	2.4	0.6	2.3	0.7	0.3	2.6	0.9

bdl = Below detection limit; LSD for pH = 1.50 significant at 1% level for 35 days. All other treatments are not significant.

Table 3. Change in pH of Red Moss peat after 45 days of aerobic incubation at 25C.

Infusion	No inhibitor			N-Serve			KEtX		
pH	3.4	5.5	6.5	3.4	5.5	6.5	3.4	5.5	6.5
No infusion	3.27	5.22	6.44	3.23	5.17	6.44	3.27	5.22	6.43
Plus infusion	3.27	5.20	6.43	3.22	5.24	6.43	3.27	5.23	6.44

None of the troatments is significant.

It has been noted that pH showed significant effect on nitrification over the control at 35 days of incubation. The best performance of nitrifiers was observed at pH 5.5.

However, except day 35, nitrification was very low althrough incubation even after liming (Table 2). This suggests the participation of autotrophs. However, it is evident that whatever may be the nature of nitrifiers (auto- or heterotrophs) they are reasonably acid-tolerant. Change in pH after 45 days of incubation was not significant.

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